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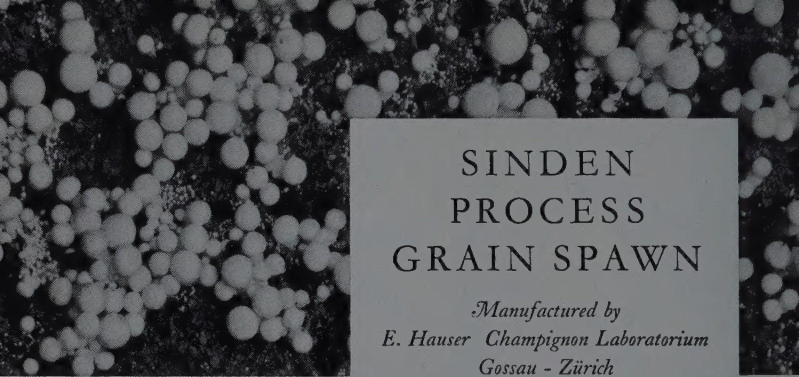

SINDEN PROCESS GRAIN SPAWN

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At the time when the mushroom grower depended on the natural occurrence of mycelium in gardens, manure piles or fields for the start of his spawn, he recognized many varieties of sporophores which differed in size, colour, smoothness of surface, productivity, etc. The early spawn maker was a sort of hunter who found that the same types appeared for many years in the same places.

When pure culture spawn was introduced, selections within the varieties were called " strains." These strains were different in appearance and productivity. The tradition of making many different varieties of mushroom spawn was continued especially by the French spawn makers. The grower had to choose from a whole series of different strains. This course is perhaps best adapted to mushroom plants in big caves with relatively constant environment over large areas, having one type of manure.

In mushroom plants above ground, however, which are filled with smaller lots of manure at different times of the year, the great variations in the conditions almost prohibit advantage being taken of the possibility of choosing the most suitable strain for each environment. The problem of selecting the right strain was thus shifted entirely to the spawn maker, with the challenge that he develop that strain which is least sensitive to changes of environment and which retains its high yielding quality combined with an optimal relationship between size, shape and surface quality under a diversity of conditions. Especially in the U.S.A., but also in some European countries, the spawn makers are now meeting the challenge year after year by maintaining a competitively good strain for a great variety of different types of mushroom nurseries and different ways of growing. This task became even more interesting and valuable with the possibility of producing a pure white mushroom combined with a smooth surface.

The discovery of the present white variety (which is not just a light shade of the cream mushroom) as a mutant on a bed in one of the mushroom houses of Mr. Lewis Downing in Chester County, Pa., U.S.A. in 1927, fortunately occurred after the pure culture technique had been developed and published by Duggar and Ferguson. When Mr. Downing called in the late Mr. L. F. Lambert, one of the important spawn makers of America, Mr. Lambert was therefore able to make pure cultures from the cluster of mutant white mushrooms. According to Mr. Lambert's reports it took several generations before all reversions to the brown mushroom had disappeared and a constantly white strain had been developed. All the present white strains used in U.S.A. have their origin in that white cluster. The culture was brought to England and in recent years to the Continent as well.

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The
MGA BULLETIN

AUGUST · 1955
NUMBER 68

EDITORIAL

ABOUT OURSELVES

Last year, at about this time, we told you something about ourselves and the problems which exist in the publication, month in and month out, of this Bulletin. Each year it is proposed to do this and so this month we lift the curtain once again.

At the beginning of this year production costs rose by £15 per month (£180 per year) and this, the first increase since 1951, was readily accepted by the Editorial Board and quite understandable. It meant however that, in order to stand on its own feet financially, the Bulletin needed an income of £145 or thereabouts every month (£1,740 per year). Somehow or other, since, with the old outgoings, there was little or no profit, the additional money had to be found if the Bulletin was to continue in its usual form. Thanks to the loyalty of our advertisers and the addition of new friends in this field, the extra money required has, so far, been found.

Our readership continues to expand, both at home and abroad, and the Bulletin provides an important link between growers in many lands. We are, we believe, an important publication, representing as we do growers in these islands and, in part, in other countries and so representing an ever expanding industry which, according to well informed opinion, has a particularly bright future.

The thanks of all members therefore are due to those members of the Editorial Board who, month by month, scrutinize the articles which appear in these pages. Special thanks too are due to our advertisers for their support and the cry from us is *Shop with our Advertisers.*

This is your Bulletin and our pages are open to you at all times should you so wish. Payment is made for all material used unless currency restrictions in some countries overseas prove too difficult.

Lastly, we freely acknowledge that we have our critics as well as those who give us a pat on the back now and then. Both are important in the well-being of any publication and are, therefore, equally welcome.

This, after all, is your Bulletin.

W.R.A.

THE CULTIVATED MUSHROOM

13—CULTIVATION

By **ANDRÉ SARAZIN**

It is not my intention to describe in detail the procedures followed by the grower in the course of his work; I am merely trying to interpret these activities scientifically in the light of certain investigations concerning the physiology of the cultivated mushroom. It will become clear that we know only very little and that there remains much to be done.

The principal works which I have consulted are by the following authors:—Atkins, 1950; Edwards, 1949; Foster, 1949; Hawker, 1951; Kligman, 1950; Rettew, 1948.

Although there is an interaction between the different factors influencing the cultivation of the cultivated mushroom, it is necessary in the interests of clarity to consider these one by one and moreover in an arbitrary manner. Furthermore this treatise will be split up into several sections.

The first of these will be devoted to the mineral elements which are necessary for the vegetative growth and reproduction of the cultivated mushroom; the second to the organic substances, taking into con-consideration the procedures which provide manures with a maximum of fertility in the course of their fermentation. Finally, the action of climate will be dealt with, in other words, the environmental factors which influence growth and reproduction, such as temperature, aeration, humidity, etc.

Nutritive requirements

The best medium for growth and reproduction is still horse manure when properly composted, a medium which is balanced both physically and chemically. This medium has acquired its properties as a result of an uninterrupted succession of fermentations due to living organisms which are sometimes antagonistic. In itself it is, when matured, a living self-balanced medium. This equilibrium is unstable, and all modifications introduced into the composition of manures at the commencement of the fermentative processes and in the factors regulating the course of different fermentative cycles, exert their influence on the final product. Now, most of the investigations concerning the nutrition of the cultivated mushroom have been carried out with pure cultures. It must not be forgotten that it is not always possible to apply in practice results obtained in pure culture. Indeed, an element acting on a mycelium growing by itself in pure culture and therefore in a sterile medium, does not always reproduce the same effects under the unsterile conditions of a living fermented manure. In such a medium the element may perhaps exert a direct influence on the mycelium itself, but it also acts indirectly on it by modifying the nature of the fermented manure by its action on the micro-organisms which are responsible for the final state of equilibrium of the compost.

The foregoing remarks are not intended as a reproach directed at all those labours which are responsible for having shed light on a little known problem, but simply to provide a warning for the reader. Moreover, I might add that, to my knowledge, no one has yet succeeded in obtaining in pure culture, on the usual sterile media, carpophores of the cultivated mushroom, and experimentation is made even more difficult by the fact that everything that stimulates growth in the cultivated mushroom does not always stimulate the production of carpophores.

Mineral Elements

It was quite natural that the first workers to investigate the elements necessary for the cultivated mushroom should focus their attention on the analysis of the ash. As it is practically impossible to separate the mycelium from its nutritive substrate, the compost, these workers confined their attention to the carpophore (Hebert and Heim 1910).

According to Anderson and Fellers (1942) the ash represents 1.26 per cent. of the fresh weight; according to McConnel and Esselen (1947) and Winton and Winton (1935) it is 1.02 per cent., or on the average 13.3 per cent. of the dry weight. According to Winton and Winton (1935) the total composition of a carpophore is as follows:

Percentages

Water 91.8, protein 4.83, fats 0.31, non-nitrogenous extract 2.04, ash 1.02.

According to Stoller the composition of the ash is as follows:—

Constituents	Percentage
K_2O	43.94
Na_2SO_4	2.31
CaO	1.32
MgO	0.21
Fe_2O_3	0.24
Mn_2O_3	0.02
Al_2O_3	2.31
P_2O_5	24.25
SiO_2	8.23
Cl	9.22
SO_3	3.01

Authors state that, because of the different methods used in presenting the ingredients and because of variations in the sampling material, quantitative analyses have not always been consistent, but reveal that the following are indispensable elements:—potassium, sodium, magnesium, sulphur, phosphorus and calcium.

Potassium

For the majority of fungi, potassium must be present in the culture medium. All fungi contain it but in much smaller quantity than that in the higher plants.

Treschow (1944) in pure culture and on a synthetic medium obtained optimum growth with minute quantities of K added to the medium.

In the presence of a concentration of .025 mole of KCl per litre no growth took place; but in the presence of a very minute quantity of calcium, 0.25 $CaCl_2$ a remarkable synergistic effect was produced and gave rise to relatively active growth. An excess of potassium was toxic. In manures, the concentration of potassium varies according to the straw which itself varies according to the amount of potash fertilizer added to the soil in which it was grown. Demolon and Burgevin (1941) have recorded that the concentration can in fact be doubled. According to Stoller (1943) the concentration of K_2O in horse manure is 2.7 per cent. of the dry weight or 16 lb. (English) per ton of manure containing 70 per cent. water. Moreover, horse urine contains it in a concentration of 10 per 1,000.

Potassium is included in most formulae for artificial manures. Stoller insists on the NPK proportions being 13 lb., 4 lb. and 10 lb. respectively, per ton of fibrous matter containing 70 per cent. humidity. Edwards (1949) confirmed these proportions but stated also that the potassium requirements vary according to the nitrogen source, being low with blood and highest with cyanamide. Kligman recorded that an excess of potassium retards the spawn 'run,' but that this effect is counteracted by supplying calcium. Lambert and Ayers (1950) did not observe any increase in yield when the amounts of potassium were increased in the presence of varying amounts of phosphorus. Finally, it should be recorded that some growers assert that they can obtain larger and whiter mushrooms by spraying the beds with a solution of 1 per 1,000 potassium nitrate.

Sodium

Sodium does not seem to be indispensable for the growth of a number of fungi; nevertheless it is found almost invariably in their ash. Its presence in manure is indisputable since horse urine contains it in the form of chlorides. No significant work on this element has so far made its appearance.

Magnesium

Magnesium is present in the ash of carpophores. Treschow obtained in pure culture, on synthetic medium, optimum growth with concentrations of .0025 to .0075 mole per litre. Magnesium is supplied in manures both in the straw and in the solid and liquid horse excrements. As in the case of sodium no special work concerning it has appeared.

Sulphur

According to G. Bertrand the carpophore contains 0.401 sulphur per cent. of the dry weight. For many fungi sulphur is useful only in small quantities but it is indispensable for good growth. Normally it enters into the composition of proteins (cystine, cystein, etc.). Treschow has himself admitted that he has not carried out any experiments in pure culture to assess the action of sulphur either in the inorganic or organic form. In his experiments sulphur was in very abundant supply in the mineral compounds of the medium. In practice the same is true; sulphur, under French conditions of cultivation, is supplied as ammonium sulphate, under English conditions of cultivation as calcium sulphate.

Later on, when considering the question of fermentation of manures, it will be seen what influence the sulphate ion can exert on the reaction of the medium when it is freed by the utilization of the ammonia in the ammonium sulphate by the bacteria which are responsible for bringing about the fermentation. Summing it up, little is known of the rôle of sulphur and much research is still required concerning it. All that is known is that this element exerts a stimulating influence on proteolytic bacteria which break down complex nitrogenous substances to ammonia during the fermentation of manures. Under fairly strict anaerobic conditions H_2S may be formed by the complete reduction of the sulphates.

Phosphorus

The cellular constituents, nucleic acids, phospholipids, respiratory enzymes and others, contain phosphorus. This element is therefore indispensable to the life of the cell.

Styer (1928), using filter paper moistened with nutritive medium, observed that without phosphorus no growth took place and that the optimum concentration was .015 to 1 mole with concentrations of sulphates of potassium and magnesium ranging from .065 to .01 mole. Treshow using fluid media considered that the optimum was .0066 mole per litre, with the reservation that the response to the concentration in phosphate was in part due to the H-ion concentration of the medium.

Pizer (1937) increased mushroom yield by the addition of superphosphate but stated that the slightest excess caused considerable harm. The optimum amount according to this author was 7 lb. (English) per ton of fresh manure. In France, the practice of sprinkling superphospate on the beds before casing is not general and does not result in an increased yield. Edwards (1949) observed a beneficial effect due to superphosphate if it was added at the fourth turning of the compost instead of at the beginning of the process. The yield was thereby definitely increased.

Normally, manure contains phosphorus. According to Stoller the concentration in phosphates is 1 per 100 of the dry weight, or 6 lb. per ton of manure containing 70 per cent. water. Straw has a phosphate concentration of 0.2 per 100 dry wt. but, as Demolon and Burgevin have stated, the concentration, as in the case of potassium, can be doubled according to the amount of phosphate manure supplied to the soil from which the straw was harvested. Moreover, solid and liquid horse manures have concentrations in phosphorus which vary according to the quantity of phosphorus-containing foods they eat.

It must be borne in mind that phosphorus is added to the manure in the form of superphosphate. This compound is the result of treating native tribasic phosphate with sulphuric acid. These native compounds are mixtures in which the predominant mixtures are water-soluble monobasic calcium phosphate, dibasic calcium phosphate soluble in ammonium citrate, tribasic calcium phosphate which is not attacked but which is soluble in acids, and residual calcium sulphate. Now, monobasic calcium is readily soluble, the dibasic form, although less soluble, is still appreciably soluble, whereas the insolubility of the tribasic form is such that it is absorbed to only a limited degree.

Doubtless, as in the case of soils, the formation of absorption compounds between the humus and phosphate must take place owing to the intermediate action of Ca (Chaminade, 1944). These compounds would occur in a form which could be more readily assimilated than soluble dibasic calcium phosphate. Depending on the time at which the superphosphate is added to the manure which becomes progressively richer in humus, the phosphates become more or less transformed into insoluble and unassimilable compounds. This hypothesis could perhaps explain the beneficial action resulting from the addition of superphosphates added at the end of the composting process which was recorded by Edwards.

Calcium

Generally speaking, calcium is not considered to be an indispensable element for all fungi; it does, however, seem to be indispensable for the cultivated mushroom.

According to Treschow, calcium is indispensable. The mycelium will not grow without calcium and calcium is antagonistic to potassium, magnesium and sodium.

Lambert (1932) strongly advocated the use of calcium sulphate in amounts of 1.5 to 2 per 100. Ware (1938) suggested that it should be supplied at the same time as the superphosphate. The results of Pizer (1937) and Thompson (1938) concerning the flocculation of humous colloids under the influence of calcium explains the beneficial physical effect of plaster in relatively moist manures, in making them less sticky and therefore more aerated and more easily penetrable for the vegetative mycelium. Treschow suggested that the action of the plaster in composts was to influence the antagonism between K and Mg to reach a favourable equilibrium. This rôle is possible, but in my opinion the action of the plaster in breaking up the colloidal emulsions of humous compounds is even more important. It is current practice in England (Atkins 1950) to add crude plaster (gypsum) at the beginning of the composting process in the amount of 28 lb. per ton (English) of fresh manure. In France the tendency is to the contrary: to supply the plaster (although this is not universal practice) either in the form of gypsum or in the form of slaked lime, by degrees, shortly before the beds are put up, and especially when the compost is very wet.

Under the circumstances created by the French methods of cultivation plaster, when sprinkled abundantly on the beds before casing, has a tendency to stimulate the excessive formation of pinheads which die before reaching maturity.

As Edwards pointed out (1949), the sheath of calcium oxalate crystals which surrounds the hyphae of the mushroom spawn in the compost is well-known without the significance of the secretion of oxalic acid in the presence of calcium being understood. According to Burrows (1949), the amounts of calcium oxalate varied from bed to bed without any apparent regard to yield or to the various treatments to which the composts were subjected.

The most important rôle of calcium in mushroom culture is that which it plays in cropping. Without calcium no mushrooms develop and all good casing soils contain calcium (Chapuis and Courtieu 1950, Lambert and Humfeld 1951).

Minerals acting as trace elements

In addition to the foregoing elements which act in fairly high concentration, there are mineral salts which are essential even in very small quantities. The study of them is made particularly difficult because of the necessity to provide chemically pure constituents of the synthetic medium as these substances could be introduced into the medium in the form of impurities.

Treschow did not observe any growth in fluid medium in the absence of iron. Optimum growth takes place in the presence of .00004 mole $FeCl_3$ per litre of medium.

Edwards (1949), taking into consideration the trace action of these elements, advocated the addition to both natural and artificial manures of various minerals in minute amounts. This mixture of salts comprises the following formula (per ton of straw, dry weight*):

Mn sulphate	12 oz.	Fe sulphate	12 oz.
Al sulphate	2½ oz.	Cu sulphate	2½ oz.
Zn sulphate	1¼ oz.	Boric acid	1¼ oz.
NH_4 molybdate ..	1¼ oz.	Cr sulphate	½ oz.
K bromide	¼ oz.	K iodide	¼ oz.

Under the aegis of this scientist, investigations were under way to ascertain if all these oligodynamic elements were really essential and what part of each was being utilized.

If, according to Treschow, iron is useful as a trace element it is definitely harmful in the form of oxide in large quantity: indeed, a length of wire in the manure is always surrounded by a black zone into which the mycelium cannot penetrate. Under the same conditions, copper, on the contrary, seems to favour growth, for a length of copper wire is always surrounded by a dense sheath of hyphae. Aluminium to a less degree produces effects similar to those of copper.

It was recorded by Montet (1932) that black oxide of uranium (U_2O_5) in the amount of 1 gr. oxide per kg. of substrate increases the yield of carpophores to a considerable degree.

Pursuing investigations on rubidium, Bertrand G. and Bertrand D. (1949) observed that the concentration of this alkaline metal in the cultivated mushroom varies in the course of the development of the carpophore from 40 mg. per kilo dry weight of young carpophores, rising to 130 mg. during the period over which the gills become pink, and diminishing again to 35 and then 30 mg. towards maturation and the shedding of the spores.

In the carpophore, the hymenium is the part of the mushroom in which the concentration of rubidium is greatest: from one and a half to twice that found in other parts of the organism. These authors think that, pending factual evidence, it is logical to suppose that rubidium fulfils a special rôle in development, and especially in connection with sporogenesis in basidiomycete fungi.

* One ounce (oz.) being the equivalent of 28.35 grams.

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Messrs. A. W. Brown, F. J. Chivers, J. S. Purbrick and J. W. Shirley, of the parent firm, continue as Directors of Shirley Organics Ltd., with the addition of Mr. V. L. Barrow as Managing Director.

Mr. Barrow is well-known throughout the mushroom industry and his many friends will wish him continued success.

ON SYNTHETIC COMPOST

7½ lb. per sq. ft. per annum

A party of 30 students from Sutton Bonington, the horticultural department of Nottingham University, under Dr. J. P. Hudson, M.B.E., G.C., visited the Yaxley farm of Noble Mushrooms Ltd. one day last month.

They were shown round by Mr. Fred. Atkins, Technical Director, and later discussed the relative advantages of synthetic and horse-manure composts, of clay sub-soil and peat as casing materials, and of manure spawn and grain spawn.

One of the most interesting features of this mushroom farm, which is one of the best known in the world, is that it was the first ever to grow solely on MRA synthetic compost. Production during the first six months of this year was equivalent to an average yield per square foot of about 2½ lb. per crop, or 7½ lb. p.a.

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I have been asked . . . . . .

WHERE SCIENCE AND PRACTICE MEET

By DR. R. L. EDWARDS

It is often said that mushroom growing is a highly scientific business, but on the other hand many growers do quite well with no appreciable knowledge of science, and I think no one would suggest for a moment that scientific knowledge can at present replace practical experience. Indeed I do not think it ever will. I am often asked about the bearing of science on particular aspects of mushroom growing, what it has done or can do, and finally the manager of a large farm put the question in a nutshell, " Where do Science and Practice Meet?"

It is certainly true, as I said above, that a man may be quite a good and successful grower without any appreciable knowledge of science, but that does not mean that he is not using the results of applied science every day on his farm. Nor does it mean that he could not be a better grower if he did know some science.

I suggested in answer to this question that science makes two different kinds of contribution to mushroom growing. But first perhaps we should consider briefly what is meant by science. My dictionary defines it as " knowledge systematised " with several variations and enlargements on that theme, and goes on to define " scientific " as " producing or containing science; according to, or versed in, science; used in science; systematic; accurate." My encyclopædia enlarges on this: "Classification of facts and the recognition of their sequence and relative significance." It includes all forms of systematised thought; therefore it is not the *facts* nor even *useful knowledge* which forms science, but the *method* in which *any* facts are dealt with.

In other words science in general is the systematic study and classification of facts. The branches of science which particularly affect the mushroom grower are biology, chemistry, and physics, dealing respectively with living organisms and life processes, the composition of all materials, animal, vegetable or mineral, alive or dead, and with physical or mechanical behaviour, energy changes, and the like.

These definitions lead directly to one kind of contribution to mushroom growing; methods of studying observed results and explanations of how and why things happen. It is not directly useful to the grower personally unless he knows enough about science to appreciate the explanations or use the methods, though in many cases he may benefit through advisers who can interpret and apply scientific methods in this way. Examples are the use of gypsum in compost, peak-heating, and Storey and Middlebrook's study of air conditions in the house.

The second kind of contribution is much more obvious to the grower, though its connection with the above definition may seem rather remote. It is the supply of materials such as pure culture spawn, heating equipment, building materials, and all the modern range of insecticides and fungicides. All of these have their origin in the "classi-

fication of facts and the recognition of their significance." All growers use these things and I think recognise the debt they owe to science for them.

Incidentally I think there is rather an implied slur on those who like to consider themselves practical men, in the suggestion that science and practice do not go side by side, that there is a point where one ends and the other starts.

Now I do not think that either of these kinds of contribution quite fills the place of science intended by the manager whose question prompted this article.

I think he had in mind the many occasions in mushroom growing when one has to decide whether a stack is wet enough or too wet, or perhaps needs another turn, whether the beds need watering, what ventilation to give, and many other questions for which the grower has to rely on his own experience and judgment. Here we do come right back to the definition " classification of facts," and it is the facts which are lacking. If we had enough accumulated data on the effect of amount and time of watering with details of previous conditions and results, these could be fed into an electronic computor, as we are told is done with weather data, to produce a usable answer.

But there are so many factors which affect these decisions, some of them not at all easily reduced to measurable terms, that an enormous mass of data would be needed to supply the computor with an adequate basis for working. Meanwhile we may as well recognise that in these respects mushroom growing is an art, as I was told some months ago by a well-known Diarist.

There is however no reason why growers should not do a little more "classification of facts" for themselves, and use more of the information available in this way. For example a record of times and approximate amounts of watering can be compared with subsequent yields.

The most efficient cropping period can be found, as described by Atkins in *Mushroom Science I*, and the cropping programme can be adjusted accordingly. The best composting period and timing of turns, whatever general system of composting is used, can be found by comparing records with yields over a sufficient number of crops.

On the practical side, ventilators can be used to take advantage of convection currents when the air in the houses is warmer than that outside, or of winds which may give end to end ventilation when convection fails in warm weather.

The time spent in keeping records of such working details, and in comparing them with yields when sufficient have been collected, is very well worth while, and in the event of a serious crop failure they may prove invaluable in seeking the cause; yet this collection and use of records fits exactly the definition "classification of facts and recognition of their relative significance." Indeed it really is applied science.

I think these examples show how very far science goes towards meeting practice. It has been applied to provide many of the materials used by the grower and to guide him in their use. It can guide him further by applying its methods to his own particular records, but it stops for lack of data on such questions as watering and control of ventilation, where practice, in the sense of the title, takes over, and the personal touch reigns supreme.

THE FRED. ATKINS ALPHABET

T—(concluded)

Thiram. The action of tetra-methyl-thiuram-disulphide is reported to be similar to that of zineb. But is it as effective? I ask, because no two zineb formulations appear to be equally effective.

Tiers. Mushroom growing without *tears?*

Timbers Preservation. Refer to the recent articles by Edwards; I don't want to make any recommendations, in case I tread on anyone's toes!

Toddington. *See* Littlehampton—when there's something to see.

Toxic Gases. Lambert suggests a 5 *per cent.* concentration of carbon dioxide will stop production in the growing house. Stoller and Mader maintain there is another (unknown) gas which is toxic.

Trace Elements. Stoller comprehensively reviewed our limited knowledge on this important subject in *MGA Bulletin* 39 (1953). The MRA formula for synthetic compost includes Stoller's suggested trace elements.

Trashing. The removal of butts and dead buttons from the bed. " Chogging " is the term preferred in some parts of the country.

Tray System. Mushrooms have been grown in boxes for more than a hundred years, but it was the brilliant idea of Henry & Herman Knaust to peak heat them in a special chamber and transfer them to another place for actual production. The system arose out of necessity; they found it impossible to pasteurize satisfactorily in their caves. The French are now adopting the Tray System in a big way.

Trichoderma Blotch. Kligman says the damage caused by this disease is often attributed to *Verticillium* (Brown Spot). Brown spots on the cap of the mushroom become darker than those due to *Verticillium* attack. They are characteristically less superficial than with Brown Spot.

Trichoderma viride. A dark green mould often found on dead butts left on the bed, or on the casing when it has been sprayed with formalin.

Truffle. The only control so far devised for this dreaded disease is the addition of 1 lb. copper sulphate in solution per ton of compost (original weight).

Turning. A stack is " turned " periodically to replenish the oxygen supply and adjust the water content. The old insistence on " upside-down, inside-out " appears to be lapsing.

Twaddle. Middlebrook tells me this Alphabet is becoming a cheap imitation of the Diary older members may remember. What twaddle! I haven't been threatened with a single libel action.

Two-Phase Pasteurization. Lambert and Ayers had astonishingly high yields when they peak-heated compost above 150° F. and then " conditioned " it at 115° F. But that is not all the story; full details were published in *MGA Bulletin* 33 (1952). No-one has adopted it in Britain, so far as I can discover.

Tyroglyphidae. This family includes several species of Mushroom Mite feeding on mushrooms.

PUBLICITY CONTRIBUTIONS STILL ADDING UP

Last month's Publicity Fund contributions included:—	£	s.	d.
The Atlas Basket Co. Ltd., Harpenden, Herts.	21	0	0
*C. Snowden & Co. Ltd., Castlefolds Market, Sheffield (Salesmen)	4	10	7
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†W. Darlington & Sons Ltd., Southcourt Road, Worthing (Spawn Merchants-Sundriesmen)			

*Previous contributions have been acknowledged
†Spawn Merchants' contributions are not for publication

SMALL ADVERTISEMENTS 3d. a word (*continued on page 716*)

MUSHROOM SPAWN MANUFACTURERS REQUIRE PRODUCTION MANAGER for new plant in the south of England. Must be experienced in the Manufacturing of Mushroom Spawn installations, etc. Substantial opportunity for the right person. All replies will be treated as strictly private. Salary and other pertinent information address to: R. C. Darlington Ltd., Hastingwood Laboratories, Harlow, Essex.

AUCTION due to termination of lease. Includes many lots of use to Mushroom Growers, including 1,500 ex-Fish type mushroom trays, iron trestles, wooden roller conveyor, etc. Sale 18th August. LETCHWORTH NURSERIES, Works Road, Letchworth, Herts.

TRAINER (24 horses) in Lewes area wishes to contact grower who will collect racing stable manure with unfailing regularity. Reasonable price. Box No. 13.

FINAL MRA REPORT

Final Report 1954 is the title of the last act played by the small company of researchers of the Mushroom Research Association and it is the seventh of the reports covering the ten years of the Station's existence. Critics must admit that the whole production has been remarkably successful; Dr. Edwards and his fellow workers may look back with satisfaction on a piece well played. The producers, a small band of enthusiastic growers who wholly financed the first years and some of whom accepted responsibility to the end for the management of their creation, will find listed the souvenirs of their efforts on the last three pages of the report.

The final report is devoted largely to investigations on the properties and functions of casing materials with particular reference to the peats. The peats seem to have been adopted by mushroom growers immediately someone had caught an aside that bales were being delivered to the laboratories of the MRA. The peats were, in fact, selected as likely materials on which to make fundamental physical measurements in the hope that the measurements would be applicable to all types of casing. The peats may continue to be used by growers but they have found little favour as media for research because ' in view of the difficulties involved in measuring the water holding capacity, pore space and related properties of peats it is concluded that for experimental purposes it is desirable to use material which is less variable.'

Nevertheless, the experiments described in the report will help those growers who use peat to a better understanding of their chosen medium and the reasons for some of their failures may well be explained. There may, too, be lessons here for the horticulturist who mixes peat in his compost for the growing of green plants.

Movement of water in soil is a complex business; Mr. Flegg has found it no less complex in the peats. Thus, the difficulty of wetting peat is due to trapped air. German sphagnum peat took 13 days to become saturated in cold water, but when the temperature was raised to 55° C. (131° F.) three-quarters of the sample was saturated within 20 hours. Sedge peats were wetted rather more easily. The water-holding capacity of a peat was found to vary significantly from bale to bale and the variation depended on factors which included density of packing, degree of saturation, particle size and previous treatment with regard to drying. When dry peat is mixed with wet peat the transfer of moisture is less than might have been expected.

The symbol pF (which represents moisture-suction) is scattered throughout Mr. Flegg's report, but it is doubtful whether this symbol will ever be cherished by mushroom growers to the same extent as that old standby pH; the relation of the former to cropping is even more subtle and its interpretation perhaps more difficult. Let the non-scientific grower be content with Dr. Edwards' elucidation that ' the crop suffers if the pF of the casing is too high, i.e., if the moisture is held too tightly.' Vermiculite, for example, may absorb water which is not available to the mushroom.

Moisture again is the main theme of Dr. Edwards' casing experiments with six different mixtures of sand and peat. Arising from these are interesting observations on the best thickness of casing and one wonders whether dishes stood on the beds for experimental purposes might not be used in commercial houses as a guide to watering.

A grower with a microscope might be tempted to see whether any of the yellow moulds in his compost agree with one of those in the nine illustrations which accompany Miss Gandy's report. In an attempt to elucidate the mystery of 'le Vert de Gris' she obtained cultures of genuine *Myceliophthora lutea* from France and U.S.A. and compared them with yellow moulds contributed by 17 growers. None of the British moulds agreed with *M. lutea*. Instead they fell into five different groups and it now remains to be seen whether these are detrimental, harmless or even beneficial to mushroom growth.

H. H. GLASSCOCK.

In France ....

CHAMPIGNON MAGNIFIQUE!!!

The mushroom to beat nearly all mushrooms is perhaps the best description which can be applied to the find of M. Felix Dubac, a commercial traveller in France.

According to *The Times*, M. Dubac picked the mushroom (or should we say levered the mushroom out of the ground) near Fix Saint Geneys (Haute Loire) in June. Described as of the Hynde variety it weighed no less than 29 lb. 12 ozs. and attracted great interest when put in display in a shop at Le Puy where the finder was on holiday.

Unfortunately the dimensions of this monster mushroom were not given but some idea can be formed when it is recalled that a 6½ lb. mushroom picked at Glandon (Haute Vienne) in September, 1953, which, according to *The Times*, was thought at that time to be a record, measured 3 ft. 9 in. in diameter and stood over a foot high.*

*This is by no means a record, as Bulletin readers will know, for in the June Issue we recorded that workmen at Le Creusot, France, once gathered two mushrooms, one weighing 105 lb. and the other 57 lb.—Ed.

In New Zealand ......

MUSHROOMS GALORE

Reports reaching The Bulletin office from New Zealand talk of heavy crops of wild mushrooms this year. The *Dunedin Evening Star* says that on one Sunday 872 lb. of mushrooms were picked and bustled aboard an express train at Marton Junction en route for Auckland. No real marketing problems, apparently, as the report states that the mushrooms were packed in boxes, biscuit tins and even *old petrol tins* and there were 86 packages in all. One consignor even sent ½ lb. in an envelope! Most of the mushrooms were picked in the Rangitikei area.

LB. PER SQ. FT. IS SO MISLEADING

Contends **E. PALFREY**

3 lb. per sq. ft. immediately evokes "In how long?"—and justifiably so. Yields and times, confusing and confounding each other, obscure real production. And inevitably, any comparisons have to balance on the not-so-parallel bars of yield and time, providing substantial mental gymnastics for even the most mathematically minded.

But do we *have* to think in two dimensions? What we want is an index which will combine the two elements of yield and time.

In this first article, production is considered. By this I mean an overall term to include the whole cultural time—cropping, casing, spawn run, peak heat, and the inevitable empty time.

In the second, the cropping and time of cropping will be considered on their own, with regard to comparisons between crops which have been allowed to crop for different times.

Comparing production between farms

Let us lift the lid off and listen to some typical frothing over this persistent pot boiler; and avoiding another, confine ourselves to shelves!

Smith: "Yes I know. It's all very well getting $1\frac{3}{4}$ lb. in 7 weeks, but if you can get 2 lb. in 10, why not get the extra $\frac{1}{4}$ lb?"

Robinson: "I maintain I am getting better production—and that's what counts—at $1\frac{3}{4}$ lb. than yours at 2 lb.; you only get an extra $\frac{1}{4}$ lb. and wait 3 weeks for it!"

Smith: "The next thing you'll be saying is that it is better to get 1 lb. in three weeks!"

Robinson: "Well look at this. In your 10 weeks you get 0·2 lb. a week—but I am getting 0·25."

Smith: "But you can't just consider the cropping time. My 10 weeks means 3 crops a year; your 7 weeks, $3\frac{1}{2}$ a year; that must be significant."

But let's close the lid (it'll go on for ages) and have a look at a way of comparing the different productions. Who is the better producer? The answer must be on an annual basis.

The 2-pounder had 3 crops p.a. =6 lb. per sq. ft. per annum.

The $1\frac{3}{4}$-pounder had $3\frac{1}{2}$ crops p.a. $=6\frac{1}{8}$ lb. ,, ,,

On production grounds, therefore, if the 2-pound could get $1\frac{3}{4}$ lb. at 7 weeks, it would be worth his while to do so. (A method giving the optimum cropping time has been described by F. C. Atkins in "Mushroom Science 1.")

But whether this is possible or not, a direct comparison between production is made on a much more satisfactory basis than lb. per sq. ft. per crop gives.

In fact, when you say you grow, whatever it is, say it in lb. per sq. ft. per year; and here, I suggest, the magic 3 pound average is translated to 8 lb. per sq. ft. per year. This is the new target and a logical one.

Comparing production within a farm

Let's listen again; another subject.

Robinson: " Well look at this: 2 lb. in 7 weeks; and compare it with our average of $1\frac{3}{4}$ lb. in 7 weeks. It's not a big increase, but I think it s the lower temperature for spawn run and our subsequent casing a week later on a firmer growth."

Smith: " But what makes you think that the 2 lb. crop is giving you better production. You spend another week in spawn run, and that means 7 days lost to production which adds up to nearly a month a year!"

Which crop is the better producer?

Here, I suggest, there are two comparisons; one based on what would happen were the crop to be repeated exactly again and again throughout a year; and the other, which I shall call the Production Index.

(i) For the first, let us calculate the annual lb. per sq. ft., were the crop to be repeated over a year, assuming the normal $1\frac{3}{4}$ lb. crop in 7 weeks gave $3\frac{1}{2}$ crops a year.

The $1\frac{3}{4}$ lb. crop (7 weeks cropping; 14·6/7 weeks from fill to fill) gives $1\frac{3}{4} \times 3\frac{1}{2}$ i.e., 6·13 lb. per sq. ft. per year.

The 2 lb. crop (7 weeks cropping; 15·6/7 weeks from fill to fill)

$$2 \times \frac{52}{15\cdot 6/7} \text{ i.e., } 6\cdot 56 \text{ lb. per sq. ft. per year.}$$

*(ii) The Production Index. This is the average production per day since filling for 1,000 sq. ft.

So, the $1\frac{3}{4}$ lb. crop gives 1,750 lb. in 99 days from filling i.e., 17·7 a day and the 2 lb. crop gives 2,000 lb. in 106 days from filling i.e., 18·9 a day.

Both show that, if we accept Robinson's contention, the increased crop is worth having at the expense of the extra week.

One can either say that, were the crops to be repeated over a year, the annual lb. per sq. ft. would be $6\frac{1}{8}$ and over $6\frac{1}{2}$; or, the Production Index, or average production per day since filling for 1,000 sq. ft., gave figures of 17·7 and 18·9.

Which is better is not easy to say, although I prefer the latter's simplicity, **but either is undoubtedly clearer and shows more accurately the relative merits of the crop productions than a straightforward lb. per sq. ft.**

*This second index is not exactly equivalent to the first as it does not take into account the empty time of the house, while the first does. I have asumed 5 days for the purpose of calculation.

This in no way detracts from its use for comparing crop productions; it simply means that (i) and (ii) are not related in a simple arithmetic way. We can in fact use (i), or use (ii).

SMALL ADVERTISEMENTS—*(continued from page 705)*

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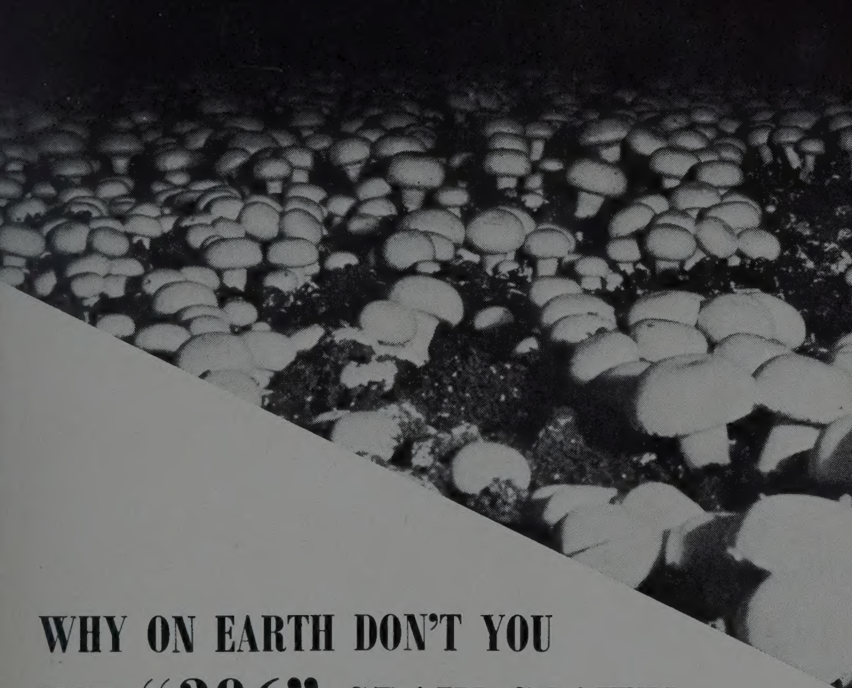

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